

SPECIAL SENSES

Introduction:

The special senses include vision, hearing, equilibrium (balance), taste and smell. In these activities you will be performing a series of physiological tests for each of these as well as, cutaneous sensations which is a somatic sense.

Activity 1: Observation of the Human Eye Model

The anatomy of the human eye includes three tunics (layers) of tissues.

The (outermost) **fibrous tunic** includes the **sclera** and **cornea**. The sclera protects and supports the eyeball and is the 'white' of your eye. The cornea is the transparent anterior portion of the fibrous tunic which refracts or bends light rays as they enter into the eye.

The (middle) **vascular tunic** includes the **choroid**, **ciliary body**, **iris**, **pupil**, **suspensory ligaments** and **lens**. The posterior choroid is blood-rich layer containing a dark pigment which prevents light from scattering within the eye. Anteriorly, the ciliary body, composed of muscle, is important to controlling lens shape through its attachment to the lens by the suspensory ligaments. As the ciliary muscles contract, the lens shape changes to allow for focusing. The iris, colored part of your anterior eye, is composed of smooth muscle and reflexively contracts to regulate the amount of light that enters through the middle opening of the iris called the pupil.

The innermost layer is the **retina**. It is extremely delicate and lines the internal space of the posterior segment of the eye extending anteriorly to cover the ciliary body. The retina is not attached to the eyeball, but is held in place by the gel-like substance of the **vitreous body** or **vitreous humor**. The retina includes a layer of photoreceptors which are specialized sensory receptors that respond to light stimuli. Extending from the retina is the **optic nerve** at the posterior of the eyeball. The site at which the optic nerve exits the eyeball, there are no photoreceptors so it is called the **optic disc** or **blind spot**. Lateral to the optic disc, directly posterior to the lens, is the **macula lutea** (yellow spot) an area of high cone (color photoreceptors). In the center of the macula lutea is the **fovea centralis**, a tiny pit (approximately 0.4 mm in diameter) that contains mostly cones and is the greatest in visual acuity.

There are two spaces within the eye. The space posterior to the lens is the **posterior segment** filled with vitreous humor. The space anterior of the lens and posterior to the cornea is the **anterior segment**. The anterior segment is filled with a clear, watery fluid called **aqueous humor**. This fluid is produced by capillaries of the ciliary body; it is responsible for maintaining the intraocular pressure, as well as, providing nutrients to the avascular cornea and lens.

Procedure:

1. Before lab, draw a diagram of the human eye in your notebook using the diagram in your text book and practice labeling the anatomical structures and spaces of the eye as indicated by the bold-faced terms above.
2. Answer the associated questions in your lab notebook.
3. During lab, observe the model of the human eye. Practice identifying the different anatomical features of the eye model.

Activity 2: Demonstration of the Blind Spot

The blind spot occurs where the optic nerve exit the retina; at this location, no vision is possible because there are no photoreceptors (rods or cones).

Experimental Procedure: *Demonstration of the blind spot for the left eye*

- 1) Hold the figure below approximately 30 cm from your eyes. If you wear glasses, keep them on.
- 2) Close your right eye.
- 3) Stare only at the cross with your left eye. You should also be able to see the circle in the same field of vision. *Slowly* move the paper toward you until the circle disappears.



- 4) You may need to repeat #3 above several times before you find the blind spot.
- 5) Slowly move the paper closer to your eyes until the circle reappears. Because only your left eye is open, you have found the blind spot of your left eye.
- 6) With your lab partner's help, measure the distance, in centimeters, from your eye to the paper when the circle first disappears and record this measurement in your lab notebook.

Demonstration of the blind spot for your right eye:

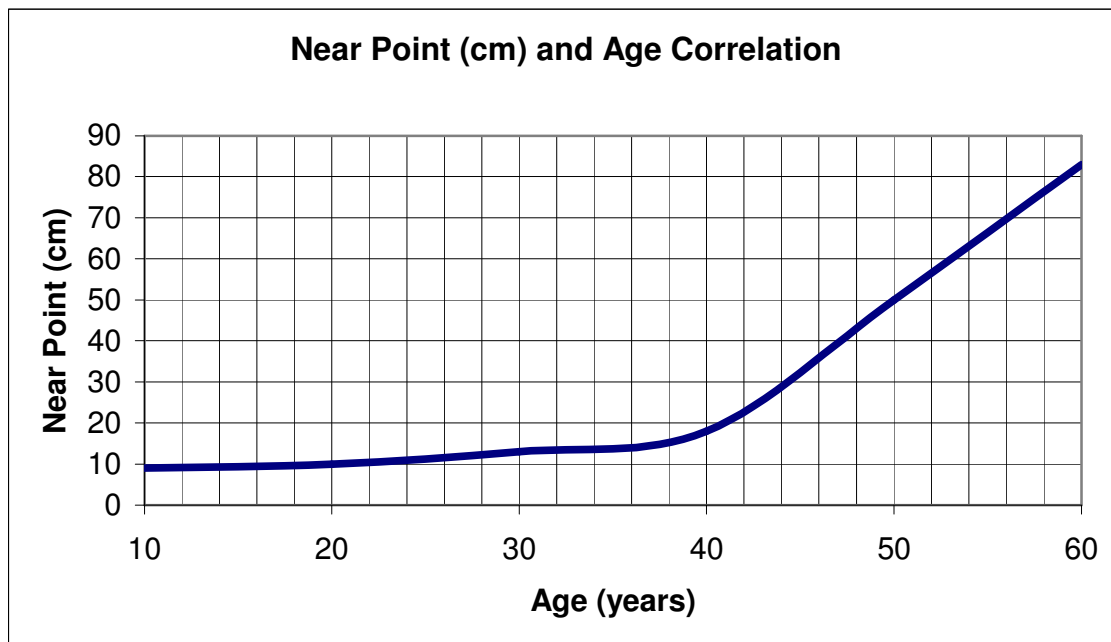
- 1) Hold the figure above approximately 30 cm from your eyes, keep your glasses on if you wear them.
- 2) Close your left eye.
- 3) Stare only at the circle with your right eye. You should also be able to see the cross in the same field of vision. Slowly move the paper toward you until the cross disappears. Repeat as necessary until you find your blind spot.
- 4) With your partner's help, measure the distance, in centimeters, from your eyes to the paper when the cross first disappears and record this in your lab notebook.
- 5) Answer all questions in your lab notebook before continuing to the next activity.

Activity 3: Accommodation

The shape of the **lens** changes in order to see objects at different distances. The **ciliary muscles** control the shape of the lens allowing it to round up or flatten in order to **accommodate** or focus on an object. The lens of the eye is elastic which directly affects how well the eye can focus on an object at different distances. As we age, lens elasticity decreases, a condition called presbyopia which requires many older people to wear bifocals in order to see near objects.

Experimental Procedure: Accommodation

- 1) Hold a pencil, upright by the eraser, at arms length in front of your right eye. Close the left eye. (If you wear glasses, keep them on).
- 2) Move the pencil from arm's length toward your eye until the tip is out of focus. Measure this distance in centimeters and record this result in your lab notebook.
- 3) If you wear glasses, repeat the experiment without your glasses. (If you wear contacts, do not remove them, however, do note this modification to the procedure in your lab notebook).
- 4) The younger, more elastic lens, can easily accommodate for closer distances. The nearest point at which the end of the pencil can be clearly seen is called the near point. Use the graph below to determine approximately how 'old' your eye is.
- 5) Repeat the experiment with your left eye and close your right eye.



- 6) Answer all questions in your lab notebook before continuing to the next activity.

Activity 4: Astigmatism

Astigmatism is a condition that results from an unequal curvature of either the cornea or the lens, which prevents light rays from being focused with equal sharpness on the retina resulting in a distorted image.

Procedure:

- 1) Work individually.
- 2) If you have glasses, remove your glasses and cover one eye. Focus on the circle in the center of the figure provided, if the radiating lines appear equally dark and in sharp focus, no astigmatism exists. If astigmatism exists, record the number of lines that appear light in color or blurred in the table of your lab notebook.
- 3) Test the other eye by repeating the procedure described above.
- 4) Repeat the test with your glasses, if you wear them.
- 5) Compare your results with several of the other students.
- 6) Answer all questions in your lab notebook before continuing to the next activity.



Activity 5: Visual Acuity

Visual acuity refers to the ability to distinguish objects in accordance with a standardized scale. It may be measured using a Snellen Eye Chart. If you can read the letters designed to be read, at 20 feet at a distance of 20 feet, you have **20/20** vision. If the smallest letters that you can read at 20 feet are those designed to be read at 30 feet, you have 20/30 vision.

Materials: Snellen Eye Chart

Procedure:

- 1) Work in pairs, each person should take a turn and report their own results in the lab notebook.
- 2) Stand at the mark (tape on the floor), 20 feet, from the Snellen eye chart on the wall, while your partner stands next to the chart and points out the lines to be read.
- 3) Cover your left eye and read the lines as requested. (You should remove your glasses before performing this test, as applicable.)
- 4) Record the rating of the smallest letters read correctly.
- 6) Repeat the test on your left eye, by covering your right eye and record the rating of the smallest letters read correctly.
- 7) Answer all questions in your lab notebook before continuing to the next activity.

Activity 6: COLOR BLINDNESS

The sensation of color vision depends on the degree to which impulses are formed by the three types of **cones** (photoreceptors for red, green and blue light) in the retina. The most common type of color blindness is **red-green** color blindness, which is caused by a deficit in cones stimulated by either red or green light. People with such a deficit have difficulty distinguishing reds and greens. A totally color-blind person sees everything as shades of gray.

Materials: Ishihara Color-blindness test plates (available in notebook or Photoalbum OnLine)

Procedure:

- 1) Work in pairs, one person will be the experimenter and record results while the other person will be the subject. Each person should take a turn at being the subject and experimenter.
- 2) Your partner, the experimenter, holds the color-blindness test plates about 30 inches from your eyes in good light and allows you 5 seconds to view each plate while you give your response.
- 3) The experimenter should record your responses in the table located in your lab notebook.
- 4) Answer all questions in your lab notebook before continuing to the next activity.

Activity 7: Observation of the Human Ear Model

The ear is responsible for both hearing and balance. The structures of the ear are often divided into three anatomical divisions. The **outer ear**, the **middle ear** and the **inner ear**.

The outer ear includes the **pinna** and **auditory canal** which collects sound waves and filters the air.

The middle ear is separated from the auditory canal by the **tympanic membrane** (ear drum). As sound moves against the tympanic membrane, it causes tiny **ossicles** (bones) to move amplifying the sound. The ossicles include the **malleus**, **incus** and **stapes** move against the **oval window**, which transmit the sound to the inner ear. Also located within the inner ear is the **round window** attached to the **auditory or Eustachian tube**; which helps to equalize the air pressure between the middle ear and the external environment ensuring that the tympanic membrane can vibrate as sound moves against it.

The inner ear includes the **semicircular canals** responsible for rotational equilibrium, the **vestibule** responsible for gravitational equilibrium and the **cochlea** which houses the mechanoreceptors responsible for hearing. The structures of the inner ear are filled with fluid and the fluid movements are responsible for producing the stimulation necessary to provide information about body position (equilibrium) and hearing sounds.

PreLab Activity:

Use your textbook to draw a diagram and label the parts of human ear in your lab notebook as indicated by the bold-faced terms. Answer the questions associated with this activity.

Activity 8: Locating Sound

Humans locate the direction of sound according to how fast it is detected by either or both ears. A difference in the hearing ability of the two ears can lead to a mistaken judgment about the direction of sound.

Materials: Tuning fork

Procedure and Observations: Record the data for your ears in your notebook.

- 1) The subject should be seated with eyes closed.
- 2) Strike the tuning fork and place the tuning fork in the following places in a *random* order. The subject should give the exact location of the sound in relation to his/her head. Record the perceptions for each position.
 - a. directly below and behind the head
 - b. directly behind the head
 - c. directly above the head
 - d. directly in front of the face
 - e. to the side of the head
- 3) Repeat the procedure so both lab partners have recorded data in their notebooks.
- 4) Answer the questions associated with this procedure in the notebook.

Activity 9: STATIC BALANCE

The inner ear is not the only receptor involved in the maintenance of equilibrium; cutaneous pressure (touch) receptors, proprioceptors (stretch receptors) in the muscles and photoreceptors in the eyes are also involved. The brain constantly receives impulses from these receptors and subconsciously initiates any necessary corrective motor actions. The following test is a simple way to observe how this interaction functions.

Materials: Whiteboard markers and whiteboard.

Procedure and Observations:

- 1) Work in pairs, one person is the subject and the other is the experimenter. Each person should have a turn being the subject.
- 2) Use a meter stick to draw a series of vertical lines on the whiteboard about 5 centimeters apart. Cover an area about 1 meter wide. This will help you detect body movements.
- 3) Have the subject remove his or her shoes and stand in front of the lined area facing you, the experimenter.
- 4) With feet together and arms at the side, the subject is to try to stand perfectly still for 30 seconds while you watch for any swaying motion. Record the degree of swaying motion as slight, moderate or great in your lab notebook.
- 5) Repeat the test with the subject's eyes closed. Record the degree of movement in your lab notebook.
- 6) Try it again to see if extending the arms laterally helps the subject to maintain balance. Record your observations in your lab notebook.
- 7) Try it once more, eyes closed, arms at the subject's side but standing on one foot. Record your observations in your lab notebook.
- 8) Answer all questions in your lab notebook before continuing to the next activity.

Activity 10: Sensory Receptors in Human Skin

One function of the skin (cutaneous membrane) is that it is a sensory surface. Human skin responds to a variety of stimuli including touch, pain, temperature and pressure. There are individual sensory receptors located within the dermis and respond to only one type of stimuli. In addition, there are free nerve endings that respond to pressure, pain and temperature.

The concentration, number, of these receptors vary from one location to the next. One way to demonstrate the variability is through **two-point discrimination**. In essence, we will be testing the ability to distinguish a pressure on the skin as being caused by two distinct objects or if the pressure feels as if it is being generated by a single object.

Materials: one of the following—hair pin, paper clip or pair of clean dry scissors

Experimental Procedure: Two Point Discrimination (Each student should record their own data in their notebook).

- 1) One partner is the subject, seated with eyes closed.
- 2) The subject is asked to identify the pressure exerted on their skin by the other partner as being caused by a single pressure or two pressures in the following four locations.
- 3) The points of the hairpin or paper clip are separated and used to simultaneously and gently touch the subject in each of the four locations.
- 4) As the subject identifies the pressure as being caused by '1' or '2' points, decrease the distance between the hairpin or paper clip points and record the shortest distance in millimeters between the two points that the subject can discriminate.
 - a. antebrachium
 - b. dorsal cervical area
 - c. index finger
 - d. posterior area of the hand
- 5) After recording your results, answer the questions in your lab notebook.

Activity 11: Adaptation to Stimuli

Your nervous system has the ability to ignore stimuli or impulses so that you are not constantly bombarded with insignificant sensations.

Materials: Several coins.

Procedure and Observations:

- 1) Work in pairs, one person is the subject and the other is the experimenter. Each person should have a turn being the subject.
- 2) Have the subject rest a forearm on the top of the table with the palm of the hand up.
- 3) With the subject's eyes *closed*, place a coin on the inner surface of the forearm and record the time in your lab notebook as the 'start' time.
- 4) The subject is to indicate awareness of the presence of the coin and also the instant the sensation disappears, record the 'end' time in your lab notebook.
- 5) Record the length of time between these two events as the adaptation time.
- 6) Repeat the test using several stacked coins to make the object heavier to increase the intensity of the stimulus. Record the times and determine the adaptation time in your lab notebook.
- 7) Answer all questions related to this activity in your lab notebook.

Activity 12: Human Chemoreceptors

Sensory receptors that respond to chemical stimuli are located on the surfaces of the tongue and lining the nasal cavities. These sensory receptors respond to molecules in the air and water.

In this procedure, each partner will be tested for the ability to sense four basic test sensations—sweet, salt, sour and bitter—over the surface of their tongue. The density of each chemoreceptor will vary with location on the tongue, so some taste sensations will be most easily identified on the tip, sides or back of the tongue.

Materials: Sterile cotton swabs, prepared solutions of 5% sucrose (sweet) , 5% acetic acid (sour), 10% NaCl (sodium chloride, salt) and 0.1% quinine sulfate (bitter).

Experimental Procedure: Taste



Biohazard—only use a single cotton swab once. No double-dipping. Dispose of cotton swabs in biohazard container.

- 1) Remove one sterile cotton swab and dip the cotton into the 5% sucrose solution. Quickly touch the subject's tongue in the following locations: tip, each side and the back of the tongue.
- 2) Record where the subject best tastes the solution in their lab notebook.
- 3) The subject should identify the taste as sweet, salty, sour or bitter.
- 4) Dispose of the used cotton swab in the biohazard container.
- 5) The subject may rinse their mouth between taste tests or get a drink of water from the water fountain.
- 6) Repeat the process using the 5% acetic acid, 10% NaCl and 0.1% quinine sulfate solutions.
- 7) Answer all questions related to this experiment in your lab notebook.

Activity 13: Relationship between Taste and Smell

The sense of taste depends heavily on stimulation of olfactory receptors. In this experiment, we will be testing each student's ability to identify a specific flavor without the stimulation of olfactory receptors.

Materials: (individually wrapped) lifesavers candy

Experimental Procedure: Taste

- 1) Each student should be the subject and try to identify three different flavors of lifesavers.
- 2) The experimenter should obtain three pieces of candy without letting the subject know what flavor the candies are.
- 3) The subject should close both eyes and hold his/her nose shut.
- 4) The experimenter should open the candy, without touching it, and drop it in the subject's free hand.
- 5) The subject should (keeping eyes and nose closed) place the candy in their mouth and try to guess the flavor of the candy.
- 6) The experimenter should record the guesses in the subject's lab notebook.
- 7) Once the subject has determined a flavor without the aid of their nose, the subject should release their nose and guess again.
- 8) Record all guesses and the actual flavor in your lab notebook.
- 9) Each student should participate and try to identify the flavor of three lifesaver candies.
- 10) Answer all questions in your lab notebook regarding this experiment.

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